

THE USE OF HALF CIRCULAR UNIT (DISH 1) TO HEAT WATER BY SOLAR ENERGY

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ABSTRACT

The research aims to design a modern solar heater, which can be used for easy manufacturing, transporting and cleaning. It is highly efficiency to heat water with low cost, and it works in different environments. The concave shape is chosen to be the basic structure of heater which is called (D1) (Dish 1), the mirrors are used to reflex the sun radiation to the copper pipe inside (D1) in order to heat the water that passes through it. The shape of D1 makes installing the glass panes on the front, against the sun easily in order to create global warming inside D1, to increase temperature of copper pipe. Throughout heat exchange, the temperature of water increases. The concave dish (Dish 1), glass panes, copper pipe and reflexive mirrors, girder of aluminum, black paint, valve and adhesive material are used in the project and a thermometer is used to measure the temperature. The project was tested from January – 2017 to May- 2018 and from January -2018 to May -2019. D1 is in vertical shape at the solar radiation, to gain the heat during the day time (direct radiation – reflection of mirrors – global warming). The experimental results explain that D1 works in high efficiency and stability. The temperature of water is (60 – 97 C°) with fixed flow (160 ml/min) during the day which means (105.6 L) of multi-use hot water. The temperature of water's tank (T₇) which keeps the hot water is (60-70 C°). D1 works during the cloudy and the partially cloudy weather and the temperature of water is (50-70 C°).

KEYWORDS: *Solar Energy, Industrial Solar Energy & Solar Heating*

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1. INTRODUCTION

Energy is important element in human's life. The decreasing of fossil oil, the main resource of this non-renewable energy, pushes the world to find other sources of energies. These new sources should be environment friendly, reducing non-renewable energy consumption, reaching over the world at reasonable prices.

Air pollution, acid rain, oil leak, nuclear risks and high temperature are what encourage to use the renewable energy as an alternative. This renewable energy is from natural sources that are always available, and does not cause environmental pollution. The main sources are: 1. Solar energy 2. Wind energy 3. Tidal energy and 4. Wave energy.

Also, the renewable energy is clean energy and environment friendly in nature. For instance, its water is naturally occurring, so there is compatibility between renewable energy and water heating [1, 2].

In 1767, a Swiss naturalist, De Saussure, built an insulated box painted black at its bottom with two panes of glass covering at the top [3]. He called it "Hot Box" which was the first example of solar water heater (SWH). It helps in cooking, heating and producing hot water. In 1891, the first commercial SWH, named Climax, was patented in US by Clarence M. Kemp [4].

In early 1900s, many of researchers focused on improving the design of SWH in order to be durable and efficient. In 1909, William Bailey designed SWH as two parts. The first part was the solar thermal collector, which collected the solar radiation. The second part was the tank, which stored the hot water. The tank was isolated to prevent heat losses [5]. SWH systems are becoming widespread. They significantly contribute in both local and industrial sectors. China, currently dominates the global solar thermal market [6].

Although SWH systems are widespread, only a fraction of the potential use has been achieved [7]. Figure (1) shows the overall percentage of SWH systems installed in the world, in different areas. In 2010, the total capacity of SWH systems and space heating systems increased by almost 16%, only about 185 GW of global thermal energy (table 1). As expected, the requirement of energy by 2030, at about 0.6% of lands will be 10% of pure solar energy [6].

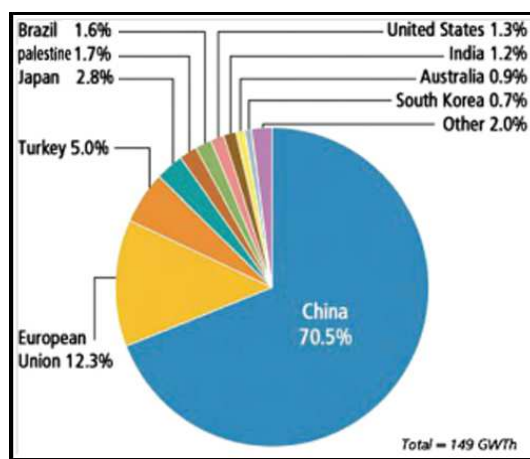


Figure 1: Solar Hot Water Heating: Existing Capacity, Top 10 Countries/Regions Published by REN21 Global Status Report in 2010.

Table 1: Existing Capacity of Solar Water Heating from the Year 2007 to 2010 [6,8]

Selected Indicators	2007	2008	2009	2010
Renewable power capacity (existing, including hydro)	1085	1150	1230	1320
Solar hot water capacity (existing) (GWth)	125	130	160	185

In general, the technology of SWH is considered integral that has attained marketing. Yet, there are several opportunities to improve the performance of the system and to be more reliable. The renewable researches become more important, since the signing of Kyoto Protocol. A big work is being done in analyzing different aspects of SWH systems, for example collector design, storage tanks and different fluids to suit regional or specific geographical conditions [9]. There are features and scope for SWH systems, and hence a detailed study on the performance of D1 devices.

The performance of any solar heater depends on the solar radiation. The solar radiation characterizes by its differences, even when abundant. It varies during the day, reaching maximum at noon when the path length through the atmosphere is the shortest, unless the collector is continuously turned to face the sun (southeast) in Basra, which lies on the longitude (47°45') and latitude (30°33') to obtain the highest temperature from solar heater [10,11,12].

1.1 Materials of D1

- Glass pane is (120 x 120 cm²) and its thickness is (0.4 cm).
- Plastic pipe to connect D1 with the tank.

- Copper pipe, diameter (1.25 cm), length (1640cm).
- Reflexive mirrors (8 x 8 cm²).
- Dark black paint.
- Tank for supplying water.
- Concave dish, diameter (118 cm).
- Valve.
- Adhesive material (silicone).
- Girder of aluminum (girder high is 3-5 cm).
- Insulated thermal tank (T_r) which keeps the hot water from D1.

2. METHODOLOGY

2.1 Manufacturing of New Half-Circle Solar Heater

The solar heater is designed in modern half-circle concave shape which is called D1, by using damaged and consumed materials. The diameter of dish is (118cm), the copper pipe is fixed on the concave side of dish by using girders of aluminum, and the reflexive mirrors are fixed under the copper pipe by using the adhesive material. See figure (2) and (3):

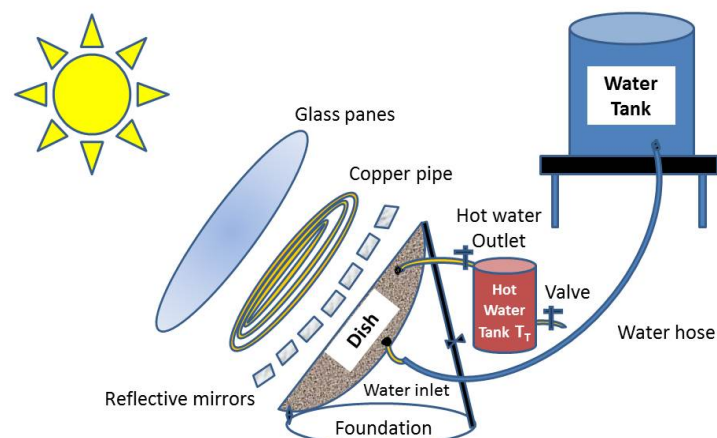


Figure 2: A Diagram of the New Solar Unit D1.



Figure 3: A Photograph of the Solar Unit D1.

The girders are fixed on the dish in equal distances, in order to raise the copper pipe in distance of (3–5 cm) on the surface of concave dish.

The reflexive mirrors are glued on the concave surface, after the girders are fixed. The mirrors ($8 \times 8 \text{ cm}^2$) are used to get more of reflexive solar radiation towards the copper pipe. Every mirror reflexes the same radiation in the same time, in order to rise the temperature of water that passes through the copper pipe by heat exchange process. See figure (4).

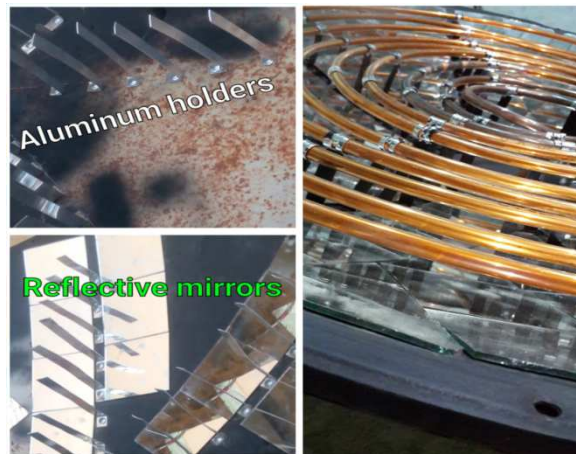


Figure 4: Shows the Holders and Reflective Mirrors.

The pipe with (1.25 cm) diameter, (1640 cm) length and (2L) capacity of water is a copper pipe, because it is easy to coil and it acquires well the heat. The copper pipe fixes on the girders in circle form after the reflexive mirrors are glued. The coil of copper pipe starts from the center to outside edge of the dish, so it takes the form of the dish on height of (3-5 cm) from the reflexive mirrors. This copper pipe of 1.25 cm diameter prevents any block that might happen in the future as other designs. See figure (5).



Figure 5: Shows the Copper Pipe User.

The copper pipe is painted with dark black to get more heat. The input of water to D1 is from the first end of the pipe, which is the center of the dish, and the output of hot water of D1 is the second end of the pipe which is in the top of dish. See figure (6).

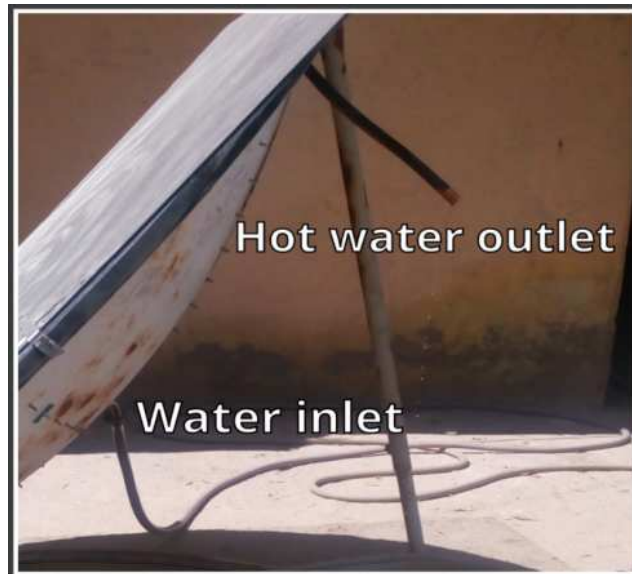


Figure 6: Shows water Inlet and hot Water outlet to D1.

The global warming principle is used to rise the temperature of the solar heater. The glass pane ($120 \times 120 \text{ cm}^2$) with thickness 0.4 cm is used as a cover of the dish to make the cleaning easy, and it glues on the edge of the dish with silicone. See figure (7).



Figure 7: Paste the Glass Plate a Cover for the Solar unit (D1).

The capacity of the copper pipe is (2L). D1 is supplied with water by external tank. The plastic pipe is connected between the tank and the center of dish. The water flow through the copper pipe to acquire heat from:

- Direct solar radiation.
- Reflexive solar radiation from reflexive mirrors.
- Global warming in the solar heater.

The valve in the second end of copper pipe is used to control the flow of output water of solar heater. See figure (8).

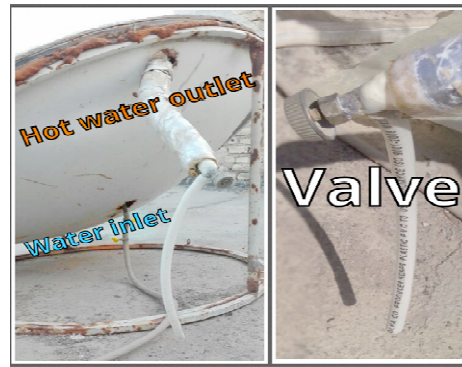


Figure 8: Shows the Valve in the Solar unit (D1).

The insulated thermal tank T_T is for the output hot water from D1. The temperature of water is (60-70 C°) after drawing (5L) to use them each hour during the operation.

In summer, the angle of D1 to be orthogonal with solar radiation is (15°). In winter, the angle of D1 to be orthogonal with solar radiation is (45°). See figure (9).

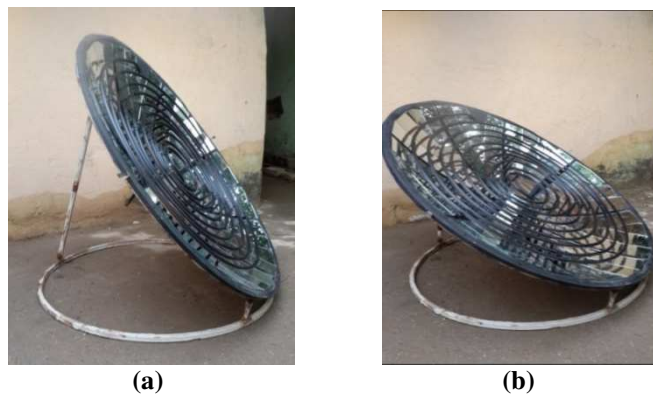


Figure 9: (a) Gradient Angle of the Solar unit in Winter., (b) Gradient Angle of the Solar unit in Summer.

After the D1 exposures to solar radiation during the day hours from January -2017 to May-2018 and from January -2018 to May -2019, many tests had been done to the design:

1- Control of flow by using the valve to reach the best results. At flow (160 ml/min), the temperature of output water from D1 is (60-97 C°) from January -2017 to May -2018.

2- D1 is tested after adding the insulated thermal tank T_T for the output hot water from D1, to use from January -2018 to May-2019, drawing 5L from T_T for using in each hour during the operation period, and recording the temperature of output water from D1 and the temperature of water in the tank T_T . The temperature of output water from D1 is (58-96 C°), which did not significantly differ from the first test, as for the temperature of water in T_T is (60-66 C°).

3. RESULTS AND DISCUSSIONS

D1 was tested during the summer and winter from January – 2017 to May – 2018, and it had been retested after a year from January -2018 to May- 2019. When D1 is faced the solar radiations from 8:00 a. m. to 6:00 p. m, the water acquires heat as shown in diagram (10).

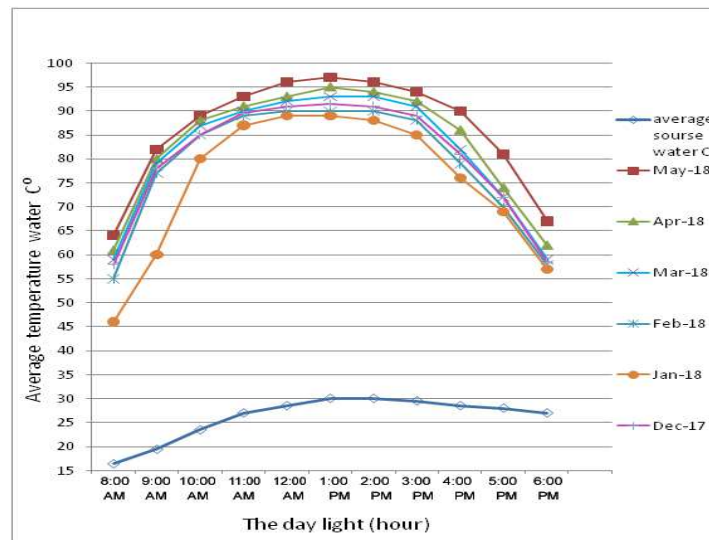


Figure 10: Shows the Diagram of Average water Temperature from D1 per Month (from December 2017 to May of 2018).

The diagram (10) shows the work of D1 during a month. Moreover, it shows the large increasing in the temperature of output water from D1, and that refers to the efficiency of design.

The temperature of output water from the D1 during the first test is (60-97 C°), which doesn't significantly differ from the temperature of water in the second test (58-96 C°). It is an evidence that D1's work is stable.

The figure (11) shows the average of monthly temperature of output water from D1 for the period from January -2017 to May – 2018.

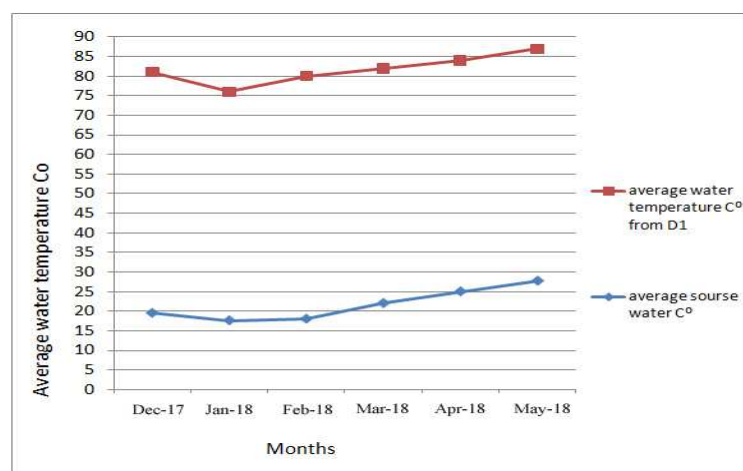


Figure 11: Shows Monthly Average Temperature to D1.

The tests on D1 indicates the stability of the flow of output water at (160 ml/min), the average of temperature is (60-97 C°) during day hours, which means (105.6 L) of multi-use hot water per day.

The temperature of water in the T_T is (60-70 C°) after drawing 5L to use them in each hour of the work.

D1 tested in cloudy weather on 5/5/2018 and the temperature was (37 C°). The temperature of output water from D1 is (50-70 C°) which means the efficiency of D1 during this weather. See figure (12) and table (2).

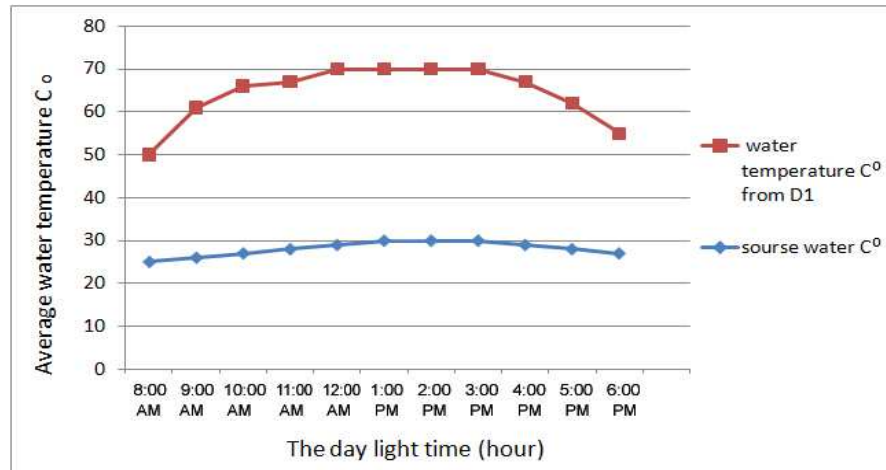


Figure 12: Shows the Average Water Temperature to D1 in a Cloudy Weather on 5-5-2018.

Table 2: Shows D1 in Windy partially Cloudy and Cloudy Weather through Day

Cloudy Weather (5/5/2018) - 37 C°			Windy Partially Cloudy Weather (16/2/2019) - 21 C°		
Time	Tow C°	T-Tank C°	Time	Tow C°	T-Tank C°
08:00	50	44	08:00	44	40
09:00	61	57	09:00	52	50
10:00	66	58	10:00	62	52
11:00	67	60	11:00	68	59
12:00	70	63	12:00	69	62
01:00	70	63	01:00	70	63
02:00	70	63	02:00	70	63
03:00	70	63	03:00	70	63
04:00	67	63	04:00	66	63
05:00	62	63	05:00	60	62
06:00	55	61	06:00	49	60

D1 retested after a year, in windy partially cloudy weather on 16/2/2019, and the temperature was (21 C°). The temperature of output water from D1 is (44-70 C°) while the temperature of water in the T_T is (50-63 C°), after drawing 5L to use them in each hour of the work. This result means, D1 is efficient in cloudy and windy partially cloudy weather. See figure (13) and table (2).

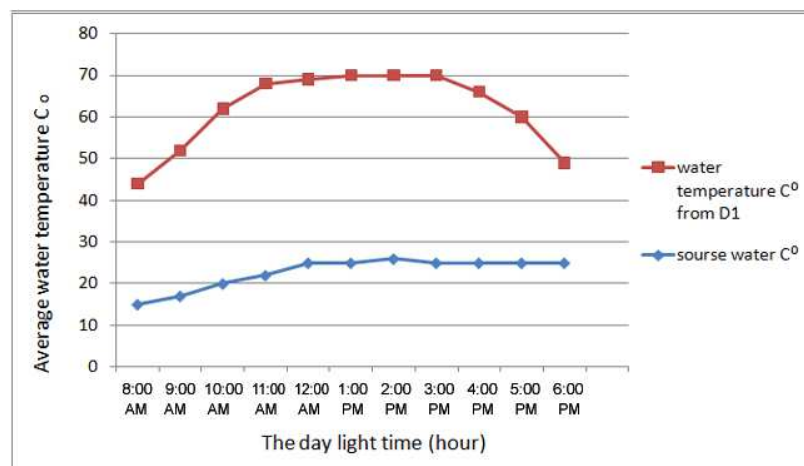


Figure 13: Shows Heater of D1 During the day Light Time.

4. CONCLUSIONS

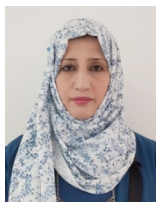
- D1 is a modern design for easy manufacturing, transporting and cleaning.
- D1 is highly efficient and stable, according to recorded results.
- The cost of manufacturing is low, and it may be lowest by using aluminum pipe instead of copper pipe.
- The temperature of water is (60-97 C°), and the flow is (160ml/min).
- D1 produces (105.6 L) of hot water after exposure to the solar radiation during the day, and the hot water keeps in insulated thermal tank. The temperature of the water is (60-70C°) after drawing 5L to use them in each hour of the work.
- D1 is efficient in cloudy and windy partially cloudy weather. The temperature of output water from it is (50–70 C°), while the temperature of water in T_T is (44-63 C°) after drawing (5L) to use them in each hour of the work.
- The guarantee is more than (5) years.

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